DEVELOPMENT OF A UNIVERSITY SEISMIC NETWORK IN METROPOLITAN LIMA, PERU

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Introduction

In high seismic hazard zones, such as Metropolitan Lima, the development of regional and local seismic networks has always been a key aspect for the evaluation of path and site effects. In this regard, the National University of Engineering (UNI), through the Japan Peru Center for Earthquake Engineering Research and Disaster Mitigation (CISMID), has been working on this matter with the implementation of CISMID Accelerometer Network (REDACIS).

The relevance of the installation of seismic sensors is intrinsically linked to the generation of open-access data, making possible the performance of accurate seismic response analyses that takes into consideration the different types of soil deposits found in Lima.

Creation and History

Even though the first available accelerogram for seismic events in Peru dates back to the late 1940s, it was very recently that the number of equipment have been constantly increasing, both in the national seismological service (Peruvian Geophysics Institute, IGP) and REDACIS.

Starting in 1988, through the contribution of the Japan International Cooperation Agency (JICA) and the National Council of Science, Technology and Technological Innovation (CONCYTEC), CISMID installed 13 analog accelerographs SM-10B RION in differents locations throughout Peru. These equipment were gradually replaced by digital ETNA Kinemetrics sensors acquired in the early 2000s (Fig. 1). A combined used of both types of accelerographs allowed recordings of seismic events such as those occurred in Atico (2001) and Pisco (2007).

In 2016, and with the financial support of the Ministry of Economy, CISMID enhanced its capabilities by means of the implementation of the Earthquake Engineering Monitoring Center (CEOIS), with the objective of remotely administrate strong motion, health monitoring, anf global positioning system. networks. For the first one, 50 130-SMA RefTek sensors were acquire to be mainly distributed in Metropolitan Lima. Table 1 shows the evolution of the available data for relevant strong motions. It has to be highlight that this information is freely avaliable through CISMID web site: www.cismid.edu.pe/ceois/red (in Spanish).

Fig. 1 (Left) SM-10B RION, (center) ETNA Kinematrics, (right) 130-SMA RefTek accelerographs implemented in REDACIS

Table 1. Summary of the important events recorded by REDACIS accelerographs, including those belonging to SENCICO national seismic network

Date	Magnitude	PGA (gal)	Epicentral distance (km)	# of stations recorded
23/06/2001	8.4 M_w	295	326	1
07/07/2001	7.6 M_w	123	110	2
25/09/2005	7.0 M_w	131	90	3
13/06/2005	7.2 M_L	139	385	7
15/08/2007	7.9 M_w	334	120	6
05/05/2010	6.5 M_L	190	104	2
25/11/2013	5.8 M_L	77	79	4
01/04/2014	8.2 M_w	72	185	4
26/05/2019	8.0 M_w	81	310	30

Current State of CISMID Seismic Network

At present, 35 digital equipment are installed in diferent locations in Metropolitan Lima, mainly in schools, universities, hospitals and municipalities. In a parallel effort, and within the framework of an agreement with the National Service of Normalisation, Training and Research for the Construction Industry (SENCICO), CISMID remotely monitors a national accelerometer network consisting on 11 Kinemetrics equipment deployed at each of the regional offices (Fig. 2).

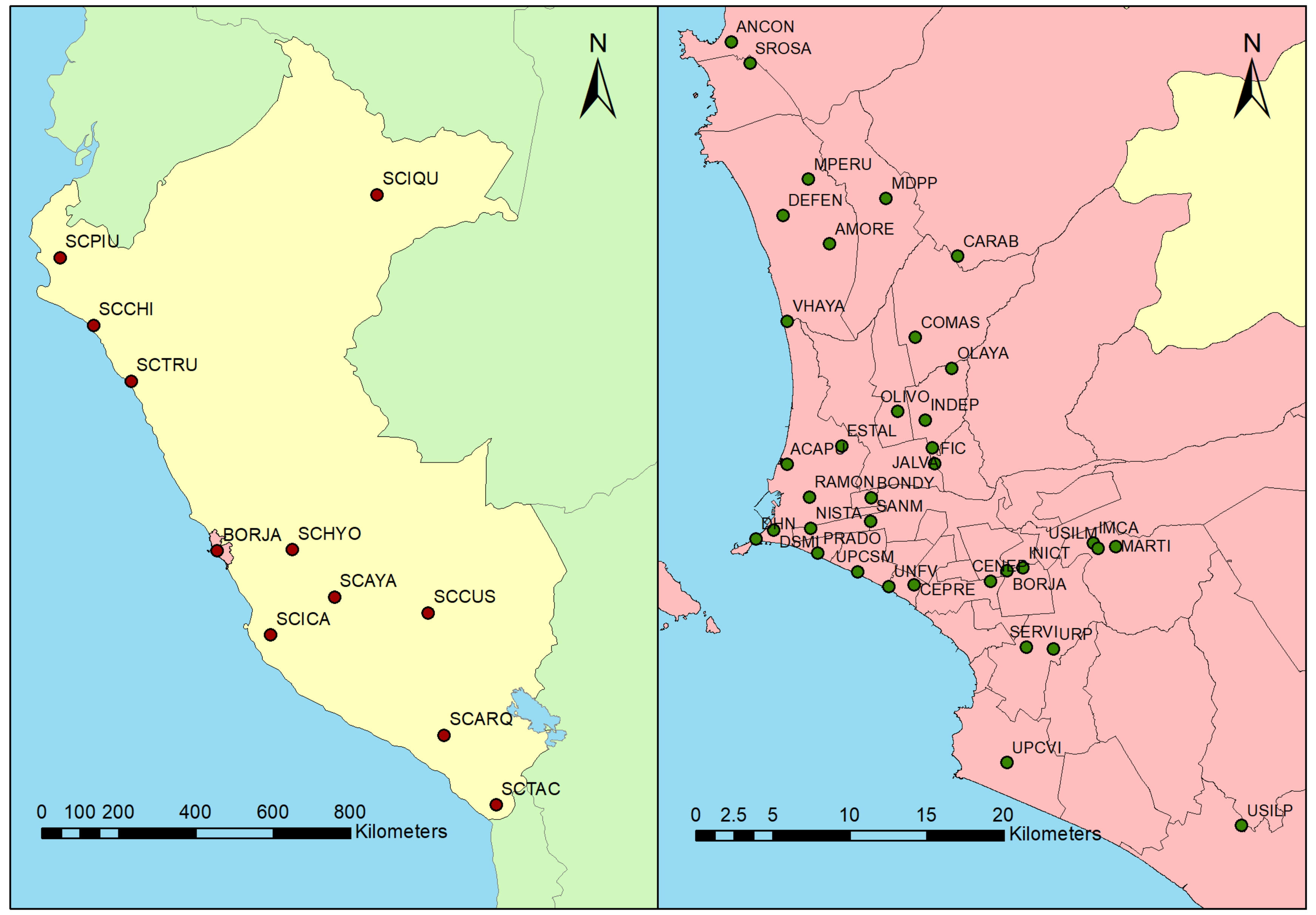

Fig. 2 (Left) SENCICO national network, (right) distribution of accelerometers of REDACIS in Metropolitan Lima

In both cases, remote communication is based on TCP/UDP protocols that allows the acquisition of signals in near real time for native and SeedLink formats.

In case of a seismic event, and with the hipocentral parameters provided by IGP, REDACIS team proccesses the data and generates reports containing relevant information, such as values of PGA, Fourier and response spectra. This information is shared with the public through social networks and CISMID website (Fig. 3).

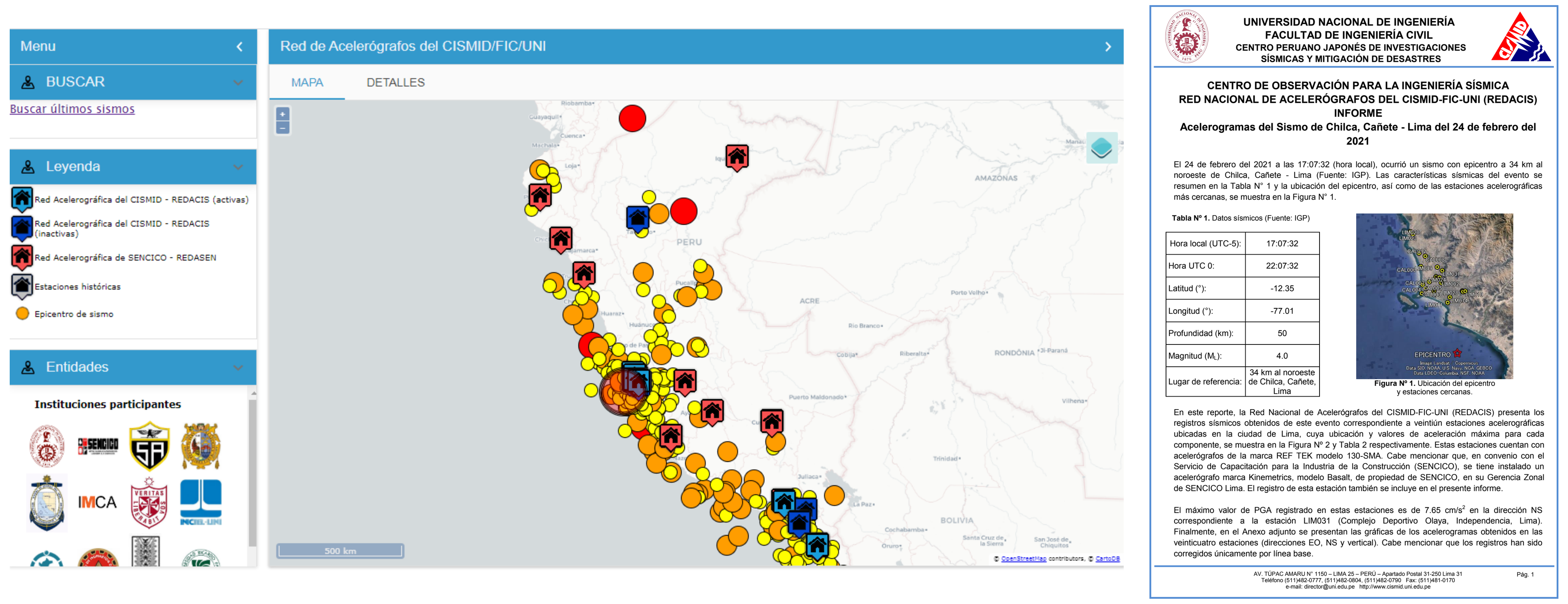

Fig. 3 (Left) REDACIS-CISMID webpage with historical data, (right) template of the generated seismic reports

Further Improvements

Within a project funded by the World Bank and Fondecyt-Peru, CISMID is planning to install the remaining accelerometers and to adequately characterize the underlying materials in terms of their shear-wave velocity distribution and fundamental period. In addition, the generated seismic data serves as empirical evidence for the update of the Peruvian Seismic Code in terms of amplification factors and other parameters involved in the shapes of the design spectra (Fig. 4).

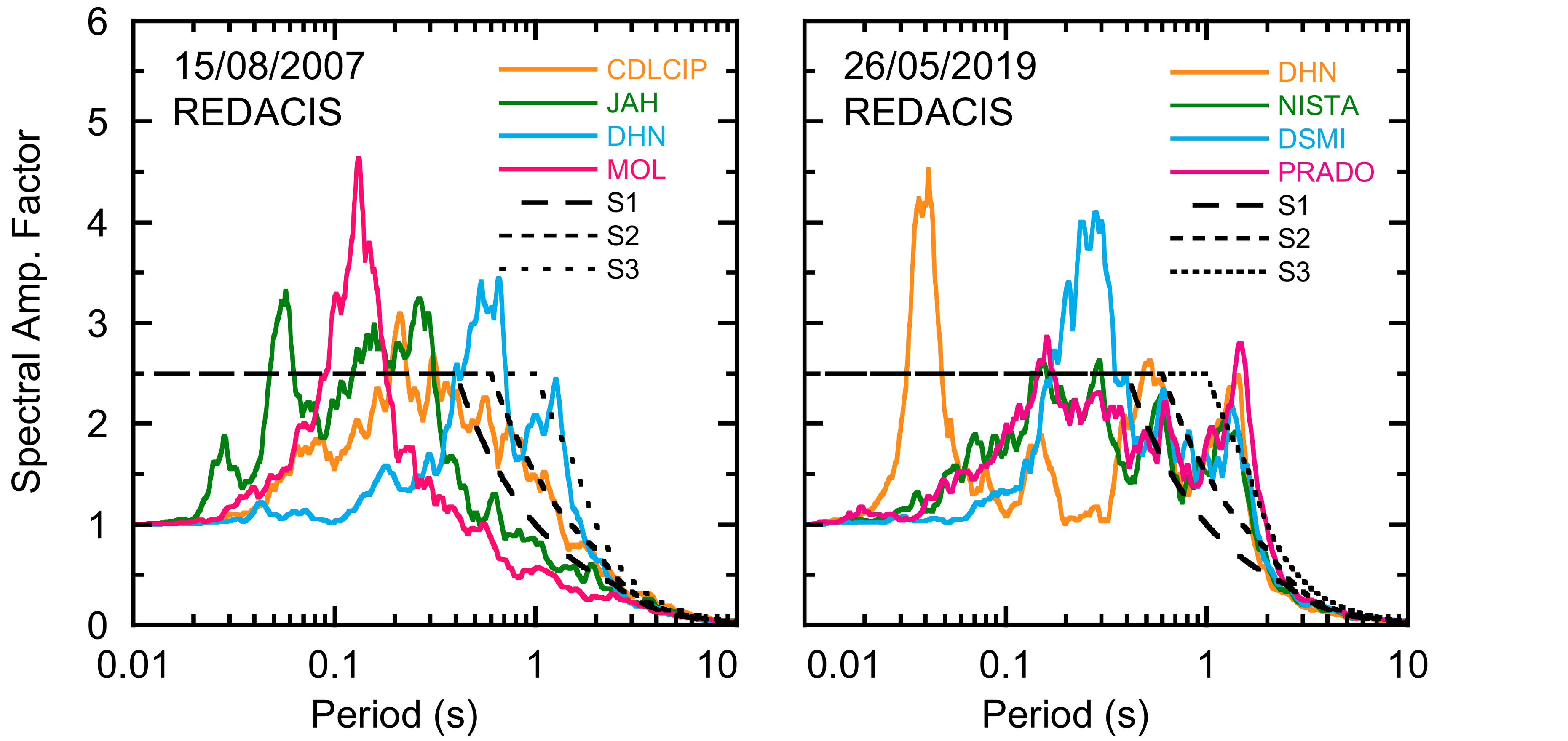

Fig. 4 Normalized response spectra for Pisco (2007) and Lagunas (2019) earthquakes